

Cumulative Risk Assessment: Overview of Agency Guidance, Practice and Current Major Research Activities

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Goals and Objectives of Presentation

- Explain background, definitions and concepts regarding cumulative risk assessment (CRA)
- Provide overview of current EPA practices, efforts and documentation relevant to CRA
- Describe EPA's CRA Guidelines effort
 - Challenges and science issues
- Highlight some of EPA's research activities on CRA

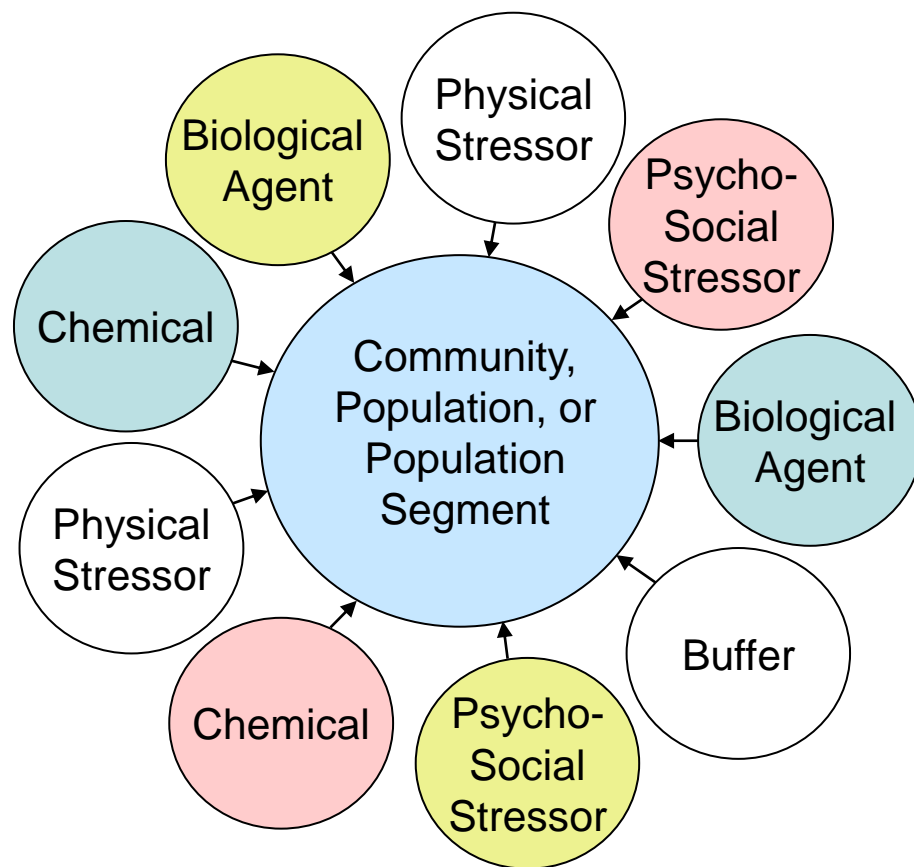
EPA's 2003 Definition of Cumulative Risk Assessment

- **Cumulative risk** is the combined risks from aggregate exposures to multiple agents or stressors, which may include chemicals, biological or physical agents
- **Cumulative risk assessment (CRA)** is an analysis, characterization, and possible quantification of the combined risks to human health or the environment from multiple agents or stressors
- CRA is population-based with stakeholder emphasis and consideration of **Vulnerability Factors**:
 - Susceptibility/sensitivity (e.g., genetics, lifestages, disease states)
 - Differential exposure (e.g., homes close to pollutant sources, diet of locally caught fish or game)
 - Differential preparedness (e.g., lack of access to health care)
 - Differential ability to recover (e.g., poor nutrition)

Source: U.S. EPA. 2003. Framework for Cumulative Risk Assessment. U.S. EPA/ORD/RAF, Washington, DC. EPA/600/P-02/001F. Available at: <http://www.epa.gov/raf/publications/framework-cra.htm>

Features of CRA

- Population focus
 - Population vulnerabilities and susceptibilities
 - Stakeholder Involvement
- Multiple chemical, physical, biological and psychosocial stressors
 - Protective buffers
- Multiple exposure routes/pathways
- Human health and ecology
 - Ecosystem services



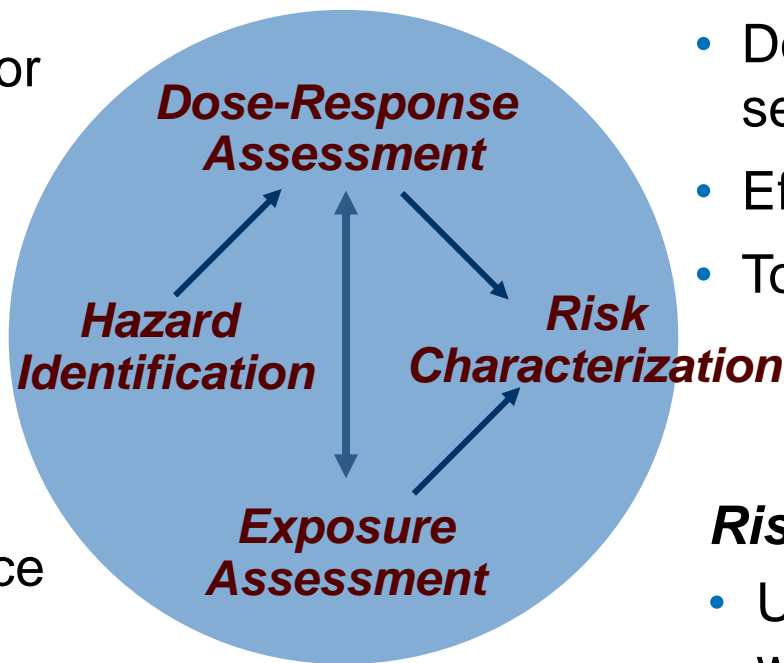
CRA Paradigm: Example Issues Beyond Those of Single Chemicals

Hazard identification:

- Effects specific to vulnerable populations
- Effects from stressor interactions

Exposure:

- Multiple exposure routes/pathways
- Social, cultural and economic factors that influence exposure
- Estimating “exposure” to nonchemical stressors



Note: Dose-response and exposure assessment are interdependent

Dose-response:

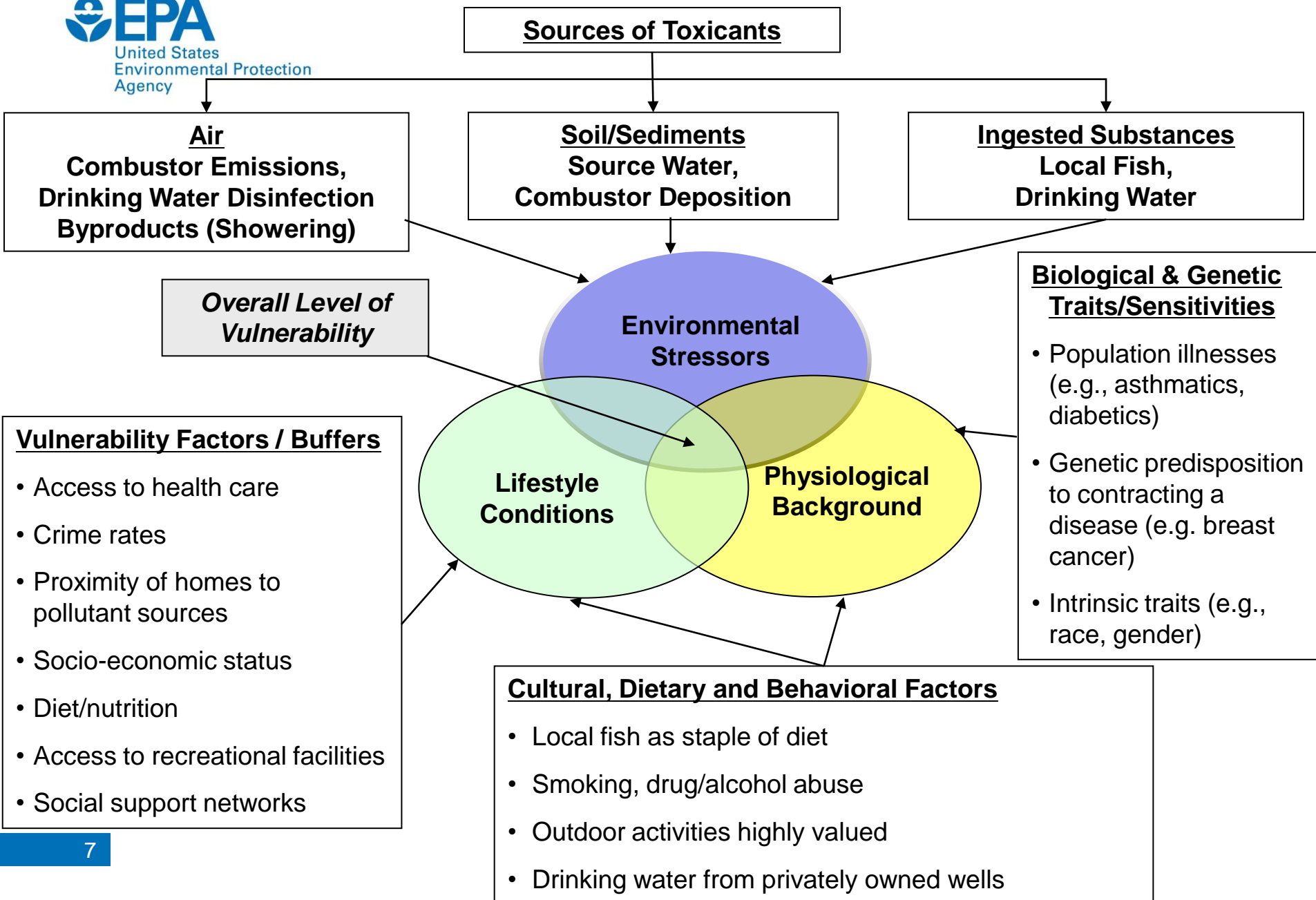
- Combined “doses” of multiple stressors
- Dose-response for sensitive populations
- Effect modification
- Toxicological interactions

Risk characterization:

- Uncertainties associated with combining risks
- Qualitative factors affecting risk outcomes



Example Stressors/Buffers for a Hypothetical Community



U.S. Progress Towards CRA

- **Scientific Publications of National Significance that Drive CRA**
 - National Research Council (NRC). 2009. *Science and Decisions: Advancing Risk Assessment*.
 - NRC. 2008. *Phthalates and Cumulative Risk Assessment: The Task Ahead*
- **Related Legislation Addressing Aspects of CRA**
 - Consumer Product Safety Improvement Act, 2008
 - CRA of phthalate mixtures for children's products
 - Clean Air Act, 1990
 - Air toxic mixtures, sensitive/differentially exposed populations
 - Safe Drinking Water Act Amendments, 1996
 - Mixtures of contaminants (chemicals, microbes) in drinking water
 - Food Quality Protection Act (FQPA), 1996
 - CRA of pesticide mixtures with common toxicity
 - CERCLA (Superfund), 1980; SARA (1986)
 - Site-specific evaluations including chemical mixtures
- **Publications in the open literature**
 - American Journal of Public Health. Vol 101, Issue S1 (Dec, 2011) *Towards Environmental Justice and Health Equality*
 - Environmental Health Perspectives. V. 115(5). (May, 2007) *Mini-Monograph on CRA*
- **State CRA Activities (e.g., California EPA's Environmental Justice Work)**
<http://oehha.ca.gov/ej/index.html>

U.S. EPA CRA Guidance and Practice

Risk Assessment Guidance
for Superfund (1989)

Methodology for
Multipathway Exposures to
Combustor Emissions (1998)

Guidance for Assessing
Health Risks of Chemical Mixtures
(1986, 2000)

5 CRA's & Guidance on
Cumulative Risk of Pesticides
(2002b;2006a,b,c;2007a, 2011)

Concepts, Methods and
Data Sources for Cumulative
Health Risk Assessment of
Multiple Chemicals, Exposures
and Effects: A Resource
Document (2007b)

Planning & Scoping for
CRA (1997)

Planning & Scoping
Lessons Learned
(2002a)

Framework for
CRA(2003)

5 White Papers on CRA:
Directions for CRA, Vulnerability,
Combined Effects of Multiple Stressors,
Environmental Mixtures,
Biomarkers (2007c)

Environmental Justice
Draft Technical Guidance
(2013 SAB Review Draft)

Example Program Office and Regional Applications of CRA Concepts

- Office of Solid Waste and Emergency Response (OSWER)
 - Planning and scoping phase (typically done for site-specific risk assessments)
 - Stakeholder involvement
 - Potentially vulnerable receptors evaluated (e.g., young children, workers) (generally done for site-specific risk assessments)
 - Multiple chemicals/multiple exposure pathways (e.g., soil, water, air)
- Office of Chemical Safety and Pollution Prevention (OCSPP)
 - Multiple pesticides, all pathways of dietary and nondietary exposures
 - Toxicity adjustments (e.g., of relative potency factors) for exposures to children
 - Exposure assessments incorporate behavioral and environmental factors
 - Develop approaches for CRA of adverse outcomes (e.g., CRA of phthalates)
- Office of Air and Radiation (OAR)
 - Chemical mixture risk assessment methods used to assess health risks from multiple air toxics under National Air Toxics Assessment (NATA), Petroleum Refinery Sector Risk and Technology Review (RTR) rules
 - Exposure estimates consider inhalation, and where data permit, ingestion
- Office of Water (OW)
 - Regulates some chemical groups as mixtures (e.g., trihalomethanes, haloacetic acids)
- Regions
 - Use of EJ Screen for geographic priority setting in regional enforcement and compliance planning
 - Implementation of OSWER guidelines in RCRA and Superfund programs

Cross-EPA Efforts and Organizational Components that Address CRA

- Risk Assessment Forum (RAF) CRA Guidelines Technical Panel
 - Articulate broad underlying principles and provide a set of descriptive (not prescriptive) science-based procedures, policies and methods specific to CRA for use by EPA's Program Offices and Regions
 - Panel members represent EPA Program and other Offices, Regions and Office of Research and Development
- Science and Technology Policy Council NRC Risk Assessment Reports Workgroup
 - Develop options and recommendations to address NRC recommendations in recent reports, including Phthalates and Cumulative Risk Assessment (NRC, 2008) and Science and Decisions (NRC, 2009)
- EPA Offices that focus primarily on the needs of vulnerable populations
 - American Indian Environmental Office
 - Office of Children's Health Protection
 - Office of Environmental Justice

EPA's RAF CRA Guidelines Effort

- **Current CRA Technical Panel in place since 2010. Efforts include:**
 - Draft CRA Guidelines outline; formation of cross-EPA writing teams
 - Draft workshop report on integrating chemical and nonchemical stressors
 - Defining and operationalizing CRA terms (e.g., vulnerability, sensitivity)
 - Draft white paper on EPA's use of dose addition in risk assessments
 - Developing tools and approaches for planning, scoping, problem formulation, risk communication
 - Developing methods for cumulative risk analysis, risk characterization
 - Public webinar series on CRA science issues [jointly sponsored with EPA's National Center for Environmental Research (NCER)]
- **Need for Collaborative Efforts**
 - Coordinate across EPA program and other offices and regions
 - Address aspects of CRA under the purview of other Federal/State agencies
 - Cultivate partnerships with academia, private industry, tribes, environmental groups, etc.

EPA RAF CRA Guidelines Science Challenges and Research Issues

- Identify and evaluate the importance of chemical and nonchemical stressors and vulnerability factors for a CRA
 - Group diverse stressors for CRA (e.g., by common exposure and toxicity)
 - Categorize diverse stressors according to their roles in modifying response (e.g., confounders, effect modifiers) to ensure use of appropriate analysis methods
- Establish analysis tiers graded by data availability/quality, resources, need
- Generate joint exposure distributions for stressor combinations; identify local at-risk populations and geographic areas
 - Address problems combining national database information (e.g., NHANES, Census, Toxic Release Inventory)

EPA RAF CRA Guidelines Science Challenges and Research Issues (continued)

- Develop/find available methods for risk analysis
 - Use epidemiology study data and traditional or high throughput toxicology data to inform health impacts of stressor combinations
 - Extend chemical mixture risk assessment methods to analyze diverse stressors
 - Characterize cumulative risks/hazards in light of uncertainties
- Develop strategies for communicating with stakeholders and risk managers regarding the CRA scope, analysis plan and results
- Consider continuing limitations in fully implementing CRA due to data and resource limitations, statutory requirements



Office of Research and Development (ORD) Research Programs and CRA

- ORD's research programs each have a role in helping to further develop cumulative risk assessment at EPA
- The Appendix to this briefing highlights current research activities related to cumulative risk

Conclusions

- CRA focus is important for getting environmental health risk assessment “right”
 - Evaluate “real world” exposures and recognize population vulnerabilities
 - Accurate and complete CRAs should result in improved environmental decision-making and risk management
 - Vulnerable populations (e.g., children, differentially exposed populations) should benefit from the conduct of CRAs
- Scientific challenges limit EPA’s current ability to implement CRA
 - EPA research plans and efforts are in place to fill gaps in available data and methods, but some science is immature
 - Primary focus to identify, measure and determine the importance of combinations of chemical and nonchemical stressors, including population vulnerabilities and buffers
- CRA Guidelines are needed to span program office and regional responsibilities while keeping EPA activities within legal mandates
 - Some aspects of CRA are already practiced by many organizations within EPA; multi-route/pathways exposures to chemical mixtures are commonly evaluated; vulnerable populations are often considered

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APPENDIX: ONGOING EPA RESEARCH RELATED TO CUMULATIVE RISK

Online. <http://www.epa.gov/research/research-programs.htm>

Office of Research and Development Strategic Research Action Plans: ACE

- Air, Climate and Energy (ACE)
 - Approaches to examine, integrate, assess multipollutant effects in toxicological and human exposure studies to estimate air pollution impacts on public health
 - Community Multiscale Air Quality (CMAQ) multipollutant modeling system to evaluate alternative control strategies to reduce air pollutants and health risks.

Office of Research and Development

Strategic Research Action Plans: CSS

- Chemical Safety for Sustainability (CSS)
 - Integrate advances in molecular biology, chemistry, high-throughput technology and computer science to rank chemicals based on hazards and risks
 - Predictive tools to identify/prioritize real-world mixtures of stressors (e.g., environmental, residential, socio-economic, dietary).
 - Tools and data for contaminants of highest priority/concern to communities, considering susceptibilities and exposures of vulnerable populations and life stages

Office of Research and Development Strategic Research Action Plans: HHRA

- Human Health Risk Assessment (HHRA)
 - CRA methods development, CRA tools and resources, joint exposures to chemical and nonchemical stressors, grouping diverse stressors for CRA, associations between health outcomes and diverse stressors, interactions among stressors, analysis of population vulnerabilities
 - Multipollutant Science Assessment in support of the National Ambient Air Quality Standards

Office of Research and Development

Strategic Research Action Plans: SSWR

- Safe and Sustainable Water Resources (SSWR)
 - Stressor/dose response models and relationships of contaminant groups
 - Methods/information for improved assessments, including cumulative health risk of contaminants groups with an emphasis on vulnerable/susceptible populations
 - Development of tools to rapidly, cost effectively, and efficiently prioritize groups of contaminants for Office of Water's Contaminant Candidate List (CCL) inclusion and criteria development

Office of Research and Development

Strategic Research Action Plans: SHC

- Sustainable and Healthy Communities (SHC)
 - Methods, measurements, models to characterize effects of environmental factors on public health; quantify, track and reduce cumulative health risks
 - Tools and approaches to assess cumulative impacts of chemical and nonchemical stressors on vulnerable populations
 - Community Cumulative Assessment (web based) Tool to navigate CRA processes (problem identification, partnership building, community stressors and ranking)

Office of Research and Development Strategic Research Action Plans: SHC (continued)

- NCER STAR grants awarded: “Understanding the Role of Nonchemical Stressors and Developing Analytic Methods for Cumulative Risk Assessments”
 - Community Stressors and Susceptibility to Air Pollution in Urban Asthma
 - Combined Effects of Metals and Stress on Central Nervous System Function
 - New Methods for Analysis of Cumulative Risk in Urban Populations
 - Hypertension in Mexican-Americans: Assessing Disparities in Air Pollutant Risks
 - Effects of Stress and Traffic Pollutants on Childhood Asthma in an Urban Community
 - Analytical Strategies for Assessing Cumulative Effects of Chemical and Nonchemical Stressors
 - Effects-Based Cumulative Risk Assessment in a Low-Income Urban Community near a Superfund Site